PROCESS FOR RECOGNIZING THE
MOVEMENT OF A MOTOR VEHICLE

FIELD OF THE INVENTION

[0001]   The present invention pertains to a process for recognizing the movement of a

motor vehicle as well as to the use of an acceleration sensor in a device for blocking the starting

of a motor vehicle.

5   ## BACKGROUND OF THE INVENTION

[0002]   Interlock systems, which are to prevent the unauthorized starting of the motor

vehicle, are installed in motor vehicles. Starting is unauthorized, e.g., if a motor vehicle is stolen

or the user of the motor vehicle is under the influence of alcohol. In the latter case, the starter in

a motor vehicle with an interlock system installed can be actuated only when the user had

10   previously undergone a breath alcohol test and the value measured in the test is below a certain

limit value. Since such a breath alcohol test is not intended to be a breath alcohol test performed by the police within the framework of a traffic check, attempts at deception cannot be ruled out, in which the breath alcohol test is circumvented or the motor vehicle is pushed or started by another person, even though the value measured in the breath alcohol test is above the limit value.

5   Such attempts of deception represent a violation of the legal conditions, have far-reaching consequences for the person involved and must therefore be reliably identified or ruled out.

[0003]   Prior-art interlock systems monitor, e.g., the vehicle system voltage in the motor vehicle, doing so even when the motor vehicle is stopped and the ignition is not turned on. However, a sample is requested for the breath alcohol test only after the ignition had been turned

10   on. The drop in the vehicle system voltage during the start-up of the motor vehicle is used here as a criterion of whether or not a start has taken place. If a drop in the vehicle system voltage is indeed registered when the breath alcohol test has not been passed, an entry is made in the memory of the interlock system, which is read, e.g., by an inspection station at monthly intervals. However, the detection of the vehicle system voltage is not a reliable criterion for the question of

15   whether the motor vehicle was started or not, because a drop in the vehicle system voltage may also be caused by turning on an air conditioner, a radio, windshield wipers or a fan in the motor vehicle.

[0004]   Another possibility of demonstrating the unauthorized starting of a motor vehicle is described in US 2002/0039951 A1. An acceleration sensor with a control means for the

20   ignition and the fuel supply is used there on a motorcycle. The acceleration sensor also takes into

account the gravitational acceleration and, in a preferred embodiment, it is able to measure the

accelerations in two directions directed at right angles to one another. Signal noise and

vibrations, which shall be left out of consideration, are eliminated by a downstream filter.

SUMMARY OF THE INVENTION

5   [0005]   The object of the present invention is to provide a process with which reliable

information can be obtained on whether a motor vehicle was moved or not.

[0006]   According to the invention, a process is provided for recognizing the movement of

a motor vehicle. The accelerating forces acting on the motor vehicle are measured at a preset

time interval by an acceleration sensor as time-dependent functions and sent to a evaluating and

10   control unit. The evaluating and control unit determines a frequency spectrum of the functions on

the basis of a Fourier analysis. If a preset percentage of the frequency spectrum is below a set

limit frequency, the evaluating and control unit stores information indicating that the motor

vehicle was moved. If the preset percentage of the frequency spectrum is not below the set limit

frequency, the evaluating and control unit stores information indicating that the motor vehicle was

15   not moved.

[0007]   In a process for recognizing the movement of a motor vehicle, the accelerating

forces are measured by an acceleration sensor as time-dependent functions and sent to an

evaluating and control unit. The time-dependent functions are subjected there to a Fourier

analysis, also called harmonic analysis. The corresponding frequency spectrum can thus be

determined. If a preset percentage of the frequency spectrum is below a set limit frequency, the

evaluating and control unit stores information that the motor vehicle was moved. If this condition

is not met, i.e., the preset percentage of the frequency spectrum is not below the set limit

frequency, the evaluating and control unit stores information that the motor vehicle was not

5   moved.

[0008]   In a preferred embodiment of the process, the accelerating forces acting on the

motor vehicle are measured by the acceleration sensor in at least two mutually independent

directions. It is ensured in this manner that one component of the accelerating forces is detected

in the horizontal direction. The acceleration sensor can therefore be installed in the motor vehicle

10   without regard to a special orientation in space.

[0009]   Depending on whether a continuous or discrete frequency spectrum is desired, the

time-dependent functions of the accelerating forces are subjected to a continuous or discrete

Fourier transformation. A discrete Fourier transformation is sufficient for the purposes of the

subsequent assessment of whether or not a motor vehicle was moved and is to be given

15   preference over a continuous Fourier transformation because it can be performed in a

comparatively simple manner in an evaluating and control unit.

[0010]   The limit frequency on the basis of which the decision is made on whether or not

the motor vehicle was moved is advantageously set as a function of the spring system and the

weight of the motor vehicle. For example, 0.3 Hz is used as the limit frequency for a usual

passenger car. A correspondingly lower limit frequency shall be selected in the case of a heavy

motor vehicle and in the case of a softer spring system.

[0011]   For example, a period between 30 sec and 60 sec is recommended as the preset

time interval at which the accelerating forces acting on the motor vehicle are measured as time-

dependent functions.

[0012]   In case of the use of an acceleration sensor in a device for blocking the starting of

a motor vehicle, the accelerating forces measured by the acceleration sensor are evaluated by an

evaluating and control unit, e.g., according to the process according to the present invention.

Independently herefrom, the evaluating and control unit receives a user breath alcohol

concentration, which is measured by means of a connected handset in the motor vehicle.

Depending on the breath alcohol concentration measured, the evaluating and control unit

energizes a relay, which will then interrupt or close a circuit to a starter by either opening or

closing a corresponding switch.

[0013]   The measured values for the breath alcohol concentration and the measured values

of the accelerating forces acting on the motor vehicle, which were evaluated according to the

process according to the present invention, are stored by the evaluating and control unit and made

available for inspections at time intervals of about one month.

[0014]   The various features of novelty which characterize the invention are pointed out

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with particularity in the claims annexed to and forming a part of this disclosure. For a better

understanding of the invention, its operating advantages and specific objects attained by its uses,

reference is made to the accompanying drawings and descriptive matter in which a preferred

embodiment of the invention is illustrated.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0015]   Figure 1   is a schematic block diagram showing a device for blocking the
starting of a motor vehicle;

[0016]   Figure 2   is a first curve showing the changes in the accelerating forces acting
on a motor vehicle over time;

10   **[0017]**   Figure 3   is a view showing the distribution of the frequencies of a discrete
Fourier analysis of the function from Figure 2;

[0018]   Figure 4   is a view showing a second curve showing the changes in the
accelerating forces acting on a motor vehicle over time; and

[0019]   Figure 5   is a view showing the distribution of the frequencies of a discrete
15   Fourier analysis from Figure 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020]   Referring to the drawings in particular, Figure 1 shows a device for blocking the starting of a motor vehicle. The device comprises an acceleration sensor 1, which detects the accelerating forces acting on a motor vehicle in two independent directions. Thus, it may be installed, e.g., under the dashboard of a motor vehicle in any orientation, and components of accelerating forces in the horizontal direction are always detected. The measurement of accelerating forces in two mutually independent directions is symbolized by the system of coordinates indicated schematically. The values measured by the acceleration sensor 1 are passed on continuously to an evaluating and control unit 2. The two functions are recorded: The g_x (t) curve showing the changes in the accelerating forces acting on the motor vehicle in the x direction over time and the g_y (t) curve showing the changes in the accelerating forces acting on the motor vehicle in the y direction over time. Two functions g_x (t) and g_y (t) are subjected by the evaluating and control unit 2 to a Fourier analysis each. The Fourier analysis provides information on the frequencies that are involved in the particular accelerating forces. The measured frequency components of the Fourier analysis are below 0.3 Hz in case of movement of the motor vehicle, as it happens during the start or during travel in a curve. Vibrations that lead to frequencies mostly above 0.3 Hz are generated during a shaking movement or a slight shock of the motor vehicle. The assessment as to whether the majority of the frequencies is below or above a preset value, 0.3 Hz in this example, is made in the following manner: The frequencies determined for g_x (t) and for g_y (t) are added up. In the case of a continuous Fourier analysis, the frequency component from 0 Hz to 0.3 Hz and beginning from 0.3 Hz would be integrated. If the frequency component from 0 Hz to 0.3 Hz accounts, e.g., for more than 50% of the total integral, movement of the motor

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vehicle can be assumed. If the frequency component from 0 Hz to 0.3 Hz accounts for less than

50% of the total integral, movement of the motor vehicle is ruled out. The frequency component

from 0 Hz to 0.3 Hz and that beginning from 0.3 Hz would be added up in the case of a discrete

Fourier analysis with frequencies at constant distances. If the sum of the frequency component

5   from 0 Hz to 0.3 Hz exceeds the sum of the frequency component beginning from 0.3 Hz,

movement of the motor vehicle is assumed in this case as well. If, by contrast, the sum of the

frequency component from 0 Hz to 0.3 Hz is smaller than the sum of the frequency component

above 0.3 Hz, an irrelevant movement of the motor vehicle, which cannot be brought into

connection with its movement, is assumed.

10   [0021]   The device for blocking the starting of a motor vehicle will be explained below on

the basis of its mode of operation:

[0022]   The motor vehicle is first started by a user. An ignition switch 6 shown in the

open state in Figure 1 is closed for this purpose. The evaluating and control unit 2 will then

activate a handset 8 via a line 7. The handset 8 is supplied with power and data are exchanged

15   between the handset 8 and the evaluating and control unit 2 via the line 7. The handset 8 is

accommodated freely accessibly and movably in the interior of the motor vehicle. The user

delivers a breath alcohol sample via a mouthpiece 9 arranged at the handset. If the alcohol

concentration in the breath alcohol sample is below a preset limit value, the evaluating and control

unit 2 energizes a relay 3, and a switch 5, shown in the opened state in Figure 1, is closed, so that

20   a starter 4 can be started.

[0023] The evaluating and control unit 2 of the device for blocking the starting of a motor vehicle receives and processes both the signals of the handset 8 and those of the acceleration sensor 1. The signals are evaluated, stored and usually read at a corresponding inspection station at monthly intervals. If a breath alcohol sample turns out to be above a preset limit value, but the acceleration sensor measured shortly thereafter accelerating forces that show predominantly frequency components in the range between 0 Hz and 0.3 Hz during the subsequent Fourier analysis, it can be assumed that the motor vehicle was moved, even though the result of the breath alcohol test was positive. This may have far-reaching consequences for the user of the motor vehicle. It is understandable from this that the statement made on whether the motor vehicle was moved or was subject only to a slight shock without any further consequence must be extremely reliable.

[0024] Figure 2 shows a first g_{x1} (t) curve showing the changes over time in the accelerating forces acting on a motor vehicle in a direction x of the two independent directions, which are measured by the acceleration sensor 1 shown in Figure 1. The time interval on the abscissa is 40 sec, and increments of 5 sec each are shown. The measured accelerating forces in m per square sec are plotted on the ordinate. Two diagonal stripes in Figure 2 correspond to 1 m/s^2 (meter per square second), indicated by the vertical double arrow.

[0025] Figure 3 shows the distribution of the frequencies of a discrete Fourier analysis of the function g_{x1} (t) from Figure 2. The value of the frequency is plotted in Hz on the abscissa. An increment of 0.02 Hz (Hertz) was selected. The amplitude of the particular frequency is

shown in a dimensionless form on the ordinate. The vertical line at 0.3 Hz marks the limit for the decision on whether movement of the motor vehicle took place. This is given here because the majority of the frequencies are below 0.3 Hz. Consequently, there is no shock that is merely insignificant, because the majority of the frequencies would be above 0.3 Hz in this case.

5   [0026]   Figure 4 shows a second g_{x2} (t) curve showing the changes over time in the accelerating forces acting on a motor vehicle in the same manner as Figure 2. Likewise, 40 sec are plotted on the abscissa at 5-sec increments. The accelerating forces in meter per square second are likewise plotted on the ordinate here. However, two diagonal stripes correspond to 0.2 m/s² here, represented on the basis of a vertical double arrow.

10   [0027]   Figure 5 shows the distribution of the frequencies of a discrete Fourier analysis of the function g_{x2} (t) from Figure 4. As in Figure 3, the frequency is plotted on the abscissa at 0.02 Hz increments in this case as well. The amplitude of the particular frequency is plotted on the ordinate. The majority of the frequencies are above 0.3 Hz here, i.e., to the right of the vertical limit line at 0.3 Hz. A shaking movement of the motor vehicle rather than its movement is
15   assumed in this case.

[0028]   While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.